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AUTHOR DeLoache, Judy S.
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ABSTRACT

Three studies investigating the emergence and early refinement of intelligent self-correction are described. Forty-one children ranging in age from 18 to 30 months served as subjects. Parents taught their children a hide-and-seek game in which the parent hid a toy in natural locations in the home while the child watched. After a 3- or 5-minute interval, the child was allowed to retrieve the hidden toy. In all three studies the children's baseline performance was excellent, with older children (25-30 months) generally doing somewhat better than younger ones (18-24 months). Certain mothers made five additional observations of their own children: two after 30-minute intervals, two after 60-minute intervals, and one after an overnight interval. The children found their toys with no errors on 88% of the trials after a 30-minute delay, 69% of the trials after an hour, and 77% of the trials after the overnight interval. In order to assess how certain the subjects were of their own memory, each subject received two surprise trials in which the toy was hidden as usual but was surreptitiously moved by the experimenter while the child was out of the room. Results showed that both the younger and the older children seemed certain of their memory for the correct location, but that they differed in their ability to re-evaluate the situation after failing to find the toy and in their flexibility in initiating alternative actions. The examples of logical searching on the part of the older children were interpreted as the exercise of a self-regulatory skill--the thoughtful correction of errors. (JMB)

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STUDIES OF MEMORY AND METAMEMORY IN TODDLERS

Judy S. DeLoache

The research I will describe here is from an ongoing project on memory in very young children. Although most parents recount numerous instances of their toddler remembering personally experienced events over days or even months, I am not aware of any published memory studies with young children where retention intervals of longer than 30 seconds have been used. It seems reasonable to infer from this discrepancy that the procedures commonly used to study early memory development are inadequate.

In the work that I will discuss today we are trying very hard to get away from artificial experimental formats and to develop more naturalistic, meaningful tasks for use with very young children. Specifically, we have taken a standard, frequently used laboratory task and transformed it into a more natural, enjoyable game. As you will see, this modification has resulted in surprisingly competent memory performance by 1½ and 2½-year-old children and has enabled us to observe some fairly sophisticated and intelligent behavior by our subjects.

We have been using the basic delayed response task introduced by Hunter (1913), which involves memory for object location (i.e., remembering where something is in space in order to retrieve it later). In my research this task has been transformed into a hide-and-seek game that the child plays with a small stuffed animal (Big Bird, Mickey Mouse). Following our instructions, the child's parents teach him or her the hide-and-seek game, and they play it for several days before our observations are made. The children are told that Big Bird is

going to hide and that they have to remember where he is hiding so they will be able to find him later. On each trial the child watches while his or her mother (or father) hides the toy in some natural location in their home, with a different location used for each trial. The specific locations obviously depend on the particular home, but include such places as behind or under chairs and couches, under pillows, behind curtains, inside desk drawers. A kitchen timer is set for a specified interval, and the child is taught to wait for the bell to ring. When it does, the child is allowed to go retrieve the "hiding" toy. The children very readily learn the rules of the hide-and-seek game and usually exhibit great delight and excitement in playing it.

One of the primary general goals of this project is to investigate the emergence and early refinement of various self-regulatory skills. These skills represent a form of metacognition, which Flavell (1978) has defined as "knowledge that takes as its object or regulates any aspect of any cognitive endeavor." The particular self-regulatory skill that will be of interest here is intelligent self-correction--i.e., given that some action has failed to achieve its goal, seeking some alternative action with greater probability of success.

Several features of the hide-and-seek game should increase the likelihood that self-regulation will appear relatively early. One of its most important aspects is that what the child remembers is manifested in action--actually retrieving an object from the environment, rather than by the purely internal retrieval of stored information. The game involves overt activity, external cues can be used, and the desired goal state (as well as success or failure in attaining it) is obvious, even to a young child. Furthermore, there is evidence that self-regulation occurs earlier in natural and familiar settings than in artificial, unfamiliar ones (Istomina, 1975).

The naturalistic features of the hide-and-seek game were also designed to avoid some of the common problems associated with testing children between one and three years of age. The pretraining provided by their parents ensures that our subjects clearly understand the task before being observed. Second, all children are observed in their own homes, playing with their mothers (or with a familiar observer), so both setting and people are familiar and non-threatening. Third, and probably most important, the children usually enjoy the hide-and-seek game enormously, so they are motivated to participate fully.

The first three studies in this project involved 41 subjects between 18 and 30 months of age. The children participated in a total of four to eight trials of the basic hide-and-seek task for one or two observation days. The delay intervals were almost always either three or five minutes (exceptionally long intervals for use with this age group). I would like to describe briefly the general level of performance we have observed in these studies, and then go on to discuss some interesting data with respect to children's search strategies.

In all three studies the children's baseline performance was excellent. They went directly (with no errors of any kind) to the hidden toy from 71 to 84% of the trials. For purposes of comparison the subjects in each study were divided into older (25-30 months, mean age = approximately 27 months) and younger (18-24 months, mean age = approximately 20 months) groups. The older children generally did somewhat better (with between 83 and 96% errorless retrievals) than the younger ones (58 to 71% correct).

While the three and five-minute intervals we used were much longer than any in the developmental literature, they did not appear to give our subjects much difficulty. In order to examine their performance at much longer intervals, we recruited some of the mothers to serve as surrogate experimenters. Each mother

made five observations of her own child in the hide-and-seek game--two with 30-minute intervals, two at 60 minutes, and one overnight. They were cautioned to put the toy somewhere the child would not happen upon it by chance. Since the mothers had been given extensive instructions about how to conduct the game with their children, and since we had observed all of them playing with the children, we were fairly confident of their ability to make objective and accurate observations for us. However, as a partial check on their data, an experimenter was present for one of the 30- or 60-minute observations for each child.

The children did surprisingly well at these longer intervals. They found their toy (with no errors) 88% of the time after a 30-minute wait, and 69% after an hour. After the overnight interval, they scored 77% errorless retrievals. (Several children, after the overnight hiding, retrieved their toy before their parents got up in the morning. One poor mother complained that her child woke her at 5 a.m., wanting to go downstairs and get Big Bird.) For anyone skeptical of mother's reports, it happens that the children <u>always</u> found their toy on the occasions we formally observed. Thus, it seems reasonable to assume the mothers' reports were not exaggerated.

Given that our young subjects did so well in the standard hide-and-seek task, it seemed reasonable to think that variations in it might elicit some simple forms of the self-regulatory skills in which we are interested. In fact, we believe that in Studies II and III we have evidence showing the appearance of one such skill, intelligent self-correction, between the ages of 18 to 30 months.

This evidence comes from an effort to examine what can be considered a rudimentary form of metamemory: we wanted to assess how certain our subjects were of their own memory. Since their performance was generally so high, one would expect that they would be quite confident that they remembered correctly,

even if they were incapable of verbalizing that confidence. A standard way of assessing certainty in preverbal infants and young children is to present a surprise trial (Charlesworth, 1969; Gelman, 1972), where the experimenter does something to disconfirm the subject's expectations. The degree of surprise shown is used as an index of how strong the expectation was.

Each subject received two surprise trials on which the toy was hidden as usual, but was surreptitiously moved by the experimenter while the child was out of the room on some pretext. The surprise trials were embedded (as Trials 2 and 5) in a series of six or seven standard hide-and-seek trials (i.e., ones in which the toy was not moved). In Study II two observers independently recorded and coded the subejcts' behavior upon looking for and not finding the toy where it had been hidden. To be conservative, we have included only behaviors noted by both observers on the surprise trials. In Study III, the subjects were videotapes while participating in the game in their homes, so data from that study have been scored from the tapes. The figures that follow reflect the combined data from the two studies.

The experimenters' subjective impressions were that the children were very surprised indeed not to find their toy on the surprise trials. Several behaviors indicative of surprise were coded and analyzed (including verbalizations and negative emotional reactions), and they substantiate the experimenters' impressions. I have previously reported those data. Today I want to discuss in detail the surprise measure that I think has turned out to be particularly interesting; it involves the patterns of searching other locations after failing to find the toy in the correct place.

I should first mention that in general, the children almost never searched a location that had not been used previously, either on that day of testing or

on a previous day. This was true for both age groups, and for both surprise trials and those trials on which subjects happened to make errors. Thus, the children had some general recollection of the set of hiding locations used.

The older and younger groups displayed different patterns of searching after failing to find their toy on surprise trials. The older children generally behaved in an intelligent fashion, much as an adult would do. After looking in the correct location and not finding the toy, they usually (on 88% of the surprise trials) searched somewhere else for it, and on the majority of the trials (76%) their searches fell into one or more of the following categories: (1) an adjacent location--if the toy had been hidden under one couch cushion, they might look under the next cushion; (2) a nearby or related location--if the toy had been put in a chair, they might look under or behind the chair; (3) an analogous location--if the toy had been hidden under a pillow at one end of the couch, they might look under the pillow at the other end of the couch; and (4) on the second surprise trial only, they sometimes looked in the place to which the experimenter had moved the toy on the first surprise trial.

The younger children were much less likely to conduct additional searches after failing to find their toy. On slightly over half the surprise trials (54%), they did not look in any other location after searching the correct one. They would often wander around in the middle of the room or stand near their mothers, apparently at a loss for what to do next. Some of the younger subjects returned to the correct location and searched there again, sometimes repeatedly. On only 26% of the surprise trials did the younger children search in the kind of related areas favored by the older subjects. They were just as likely, when they searched somewhere, to go to a place where the toy had been hidden on an earlier trial

(especially the immediately preceding one). This tendency to search a prior location is reminiscent of the Stage IV error in object permanence (Harris, 1975) and the perseverative errors frequently observed for toddlers in memory and problem solving tasks (Webb, Massar, & Nadolny, 1972).

The older children's tendency to search additional locations on surprise trials reveals a form of certainty of memory in that they concentrated their searching in areas that were nearby or logically related to the correct location. They looked in places where the toy might reasonably be. They seemed to allow for the possibility that they misremembered some detail ("maybe it's under this cushion instead of that one") or that some fairly plausible event intervened ("maybe the toy fell out of the chair"). One subject verbalized exactly this: he looked in the desk drawer in which his toy had been hidden, said "Did Mickey Mouse fall out?", and then proceeded to search behind the desk. The children were also alert to the possibility that the experimenter was tricking them a second time.

Thus, both the younger and older children seem certain of their memory for the correct location, but they differ in their ability to re-evaluate the situation after failing to find the toy and in their flexibility in initiating alternative actions. The younger children most often do nothing at all. When they do, they are as likely to simply go to a prior hiding place as to search in a related location. The older children are more flexible and logical in their attempt to deal with the disconfirmation of their expectations. They are able to reflect on the situation and consider where the toy must be, given it is not where they remembered. To account for its absence, they appear to consider plausible physical or mental explanations: something happened to the toy, or some detail of their memory must be faulty.

These examples of logical searching on the part of the older children (and a few of the younger ones) represent the exercise of a self-regulatory skill--thoughtful correction of errors. When the children fail to find the toy, they can only assume that they are in error (at least on the first surprise trial). They then try to correct that supposed error by thinking about where the toy is most likely to be. They proceed to conduct the same sort of organized, logical search that an adult might do. If you remembered that you had left your car keys on the top of the kitchen counter but then couldn't find them, you would probably search for them behind the cookie jar on the counter and on the floor around the counter.

In summary, the young children who participated in the research described here performed very competently. They did excellently in the basic hide-and-seek game, which they understood and enjoyed playing, even with extended delay intervals. Furthermore, they showed what is probably the earliest evidence yet observed of self-regulation by the logical search procedures they employed on the surprise trials. The competent and sophisticated behavior of our young subjects suggests that if we make the effort to make our tasks more comprehensible and meaningful to young children, they may in turn be more enthusiastic research participants and provide us with more valid data.